DECREASE IN PERCEIVED DISTORTION WITH REPEATED EXPOSURE:

Application for Naval Diver Training

by

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SUMMARY PAGE

THE PROBLEM

Inexperienced divers are unable to function effectively in the visually distorted underwater environment. This paper presents preliminary investigations aimed at developing training techniques to improve the performance of inexperienced Naval divers.

FINDINGS

Repeated exposure to a distorted visual environment lessens the amount of distortion perceived. This advantage of previous exposure will transfer to a second visual distortion provided that the individual was not overtrained on the first.

APPLICATION

The data suggest that training techniques can be developed and employed out of water which will enable inexperienced Naval divers to function more effectively in the distorted underwater environment.

ADMINISTRATIVE INFORMATION

This investigation was conducted as a part of Bureau of Medicine and Surgery Research Work Unit MF12.524.004-9014D, Improvement of Vision and Orientation Underwater. The present report is No. 5 on that Work Unit. It was approved for publication on 16 Feb 1970 and designated as Submarine Medical Research Laboratory Report No. 613.

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ABSTRACT

With repeated exposure to a distorted visual environment, an individual perceives less distortion on each subsequent occasion. This positive advantage of repeated exposure is found to transfer to a different distortion, provided the subject has not had too much experience with the first distortion. Overtraining on one distortion cancels any positive transfer of advantage from one distortion to another. It may, therefore, be possible to train Naval divers, out of water, to perform more effectively as soon as they enter the water.

INTRODUCTION

When an inexperienced diver first enters the water, he experiences a distortion that affects the appearance of both the size and the distance of objects. This distortion, caused by the refraction of light rays as they pass from water to air, results in the apparent magnification of objects under water to approximately 4/3 their actual size. They also appear at 3/4 of their actual distance.

Recent experiments by Kinney, Luria, & Weitzman[1] and Kinney, Luria, Weitzman, & Markowitz[2] have suggested that highly experienced divers (several years diving) are able to compensate almost completely for the distortion immediately upon entering the water. Less experienced divers have considerable difficulty in reaching for objects, and the degree of competence achieved is directly related (r=.85) to the amount of underwater experience the diver has had.[2]

In water, at least, it appears that there is a definite advantage to be gained from repeated exposure to the distorted environment (i.e., less distortion is perceived in each subsequent exposure). If this advantage could be shown to transfer to a second distortion then it may be possible to train divers, out of water, to perform more effectively immediately upon entering the water.

Previous attempts to demonstrate that repeated exposure to distorting lenses may lessen the amount of distortion perceived in subsequent exposures have failed.[3,4,5] Unfortunately, these studies did not allow a long enough time interval between trials to enable the after-effects of the previous exposure to dissipate. This same criticism is true of at least one study that failed to find any transfer of effect from one distortion to another.[6]

The present study used lateral displacement of a visual target to test the effect of previous exposure to distortion on subsequent exposure to either the same or a different distortion.

METHOD

Subjects

Twenty-four right-handed Navy enlisted men volunteered to participate in the experiment. They ranged in age from 18 to 25 years. None had any previous experience in perceptual adaptation tasks.

Procedure

Upon arrival each S was randomly assigned to one of four experimental groups. Each S was run every day for five successive days and remained in the same group for the entire course of the experiment.

Two of the groups started with either base-right or base-left wedge prisms and adapted to the same base prisms every day for the first four days (Constant Base group). The fifth day they adapted to the opposite base prism.

The other two groups started the first day with either base-right or base-left prisms but were given the opposite base prism on alternate days (Switched Base group).

Distortion was produced by twenty diopter wedge prisms; these yield an 11 degree shift of the visual field to the right or left; depending on the direction of the base.

A placing task was used for the adaptation periods and for test periods to measure the amount of compensation and after-effect. The task was to place a small chess-piece on a checkerboard grid in one of three designated locations. Each target location was used twice in each test period for a total of six trials per test; responses were recorded to the nearest 1/4 inch. During testing S first looked at the appropriate square on the checkerboard; then his eyes were covered and he attempted to place the marker in the center of the target square.

Each adaptation period consisted of twenty placing trials. During the first ten of these trials, the subject was permitted to watch his hand during the entire placing action (continuous feedback). On the other ten trials, the subject first looked at the designated square and then his eyes were covered as he placed the marker on the target. After returning his hand to his side, he was permitted to again view the grid and to see where he had placed the marker (terminal feedback). Both methods of adaptation were used to ensure that the subject achieved the maximum amount of compensation possible in the time permitted.

The daily procedure consisted of a training period with prisms which was continued until a criterion of three consecutive placements within 1/2 inch of the target was met. Training was followed by a testing period without lenses; these data served as a measure of the S's constant error for that day. The S then put on the prisms and was given a standard test period, a one-minute adaptation period, a second test, a second adaptation period, and a final test, all with the prisms in place. The three test periods thus yielded one measure of the original distortion and two measures of the amount of compensation achieved over time.

To test after-effect, the prisms were then removed and the entire procedure repeated without them. There were thus three measures of after-effect, one immediate and two of decay after the two one-minute adaptation periods.

RESULTS

Figure 1 presents the error in responding due to distortion for each group during the first testing session each day. The measure is the amount of shift, in inches, from the subject's original responses without prisms on that day.

Errors decreased steadily from the first day to the third day for both

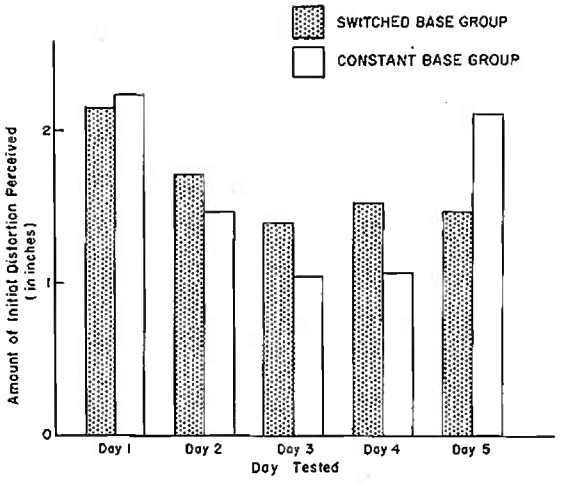

Fig. 1. Average amount of initial distortion perceived by the Switched Base Group (striped bar) and the Constant Base Group (solid bar) on each day.

groups. For the SB Group the amount of initial shift then stabilized and remained the same for the next two days.

The initial distortion perceived by the CB Group remained the same for Day 3 and Day 4 but increased markedly on Day 5 when the direction of the prism base was finally changed. The errors evidenced by the CB Group were the same size on the fifth day as on the first day of the experiment. Table I presents the statistical analysis of the differences in the amount of initial shift (error) across days for each group.

Table II shows the amount of distortion perceived by Day for each of the measures of compensation and after-effect. There was no difference in the initial displacement shown by the two

Table I. Statistical Analysis of Differences in the Amount of Initial Shift Across Days

Comparison	Constant Base Group		Switched Base Group	
	Difference between means (in inches)	t df=12	Difference between means (in inches)	t df=10
Day 1 - Day 2	0.74	3.05*	0.44	1.99*
Day 2 - Day 3	0.43	2.50*	0.32	2.21*
Day 3 - Day 4	0.02	0.18	0.14	0.71
Day 4 - Day 5	1.04	4.00**	0.06	0.44
Day 1 - Day 5	0.10	0.43	0.69	3.82**

* P <.05
**P <.005

Table II. Amount of distortion by day (in inches) for Switched Base (SB) and Constant Base (CB) Groups

Days	Initial Shift	Compensation		After-Effect		
		I	II	I	II	III
SB Group						
1	2.16	.44	.26	.76	.39	.38
2	1.72	.36	.16	.74	.37	.26
3	1.40	.41	.37	.45	.14	.14
4	1.53	.28	.10	.68	.34	.24
5	1.48	.41	.40	.53	.19	.16
CB Group						
1	2.22	.74	.29	.68	.31	.24
2	1.48	.52	.33	.46	.18	.10
3	1.05	.48	.35	.43	.18	.11
4	1.07	.37	.22	.32	.13	.11
5	2.11	.69	.25	.51	.30	.23

groups on the first day. There was also no difference on any of the other measures of compensation and after-effect during the course of the experiment, although the size of the original after-effect tended to decrease over days.

DISCUSSION

The results indicate that exposure to distortion has a cumulative effect. The same initial measure on subsequent days showed increasing amounts of immediate adaptation. Furthermore, there was some indication of a transfer of the training effect from one type of distortion to another.

Using minifying spectacles Foley and Abel[3] and Foley[4] were unable to demonstrate that the magnitude of initial shift and after-effect decreased with repeated exposure to distortion. Ebenholtz[6] and

Lazar and Van Laer[5] both failed to find either positive or negative transfer from one distortion to another.

Lennie,[7] on the other hand, did demonstrate a decrease in the magnitude of shift when the distortion remained the same across sessions, but found negative transfer when the distortion was changed. All of these studies involved closely spaced trials (massed trials) and lengthy adaptation periods (overtraining) which may not be conducive to transfer.

To avoid the possible detrimental effects of overtraining and massing of trials, the present study allowed a 24-hour break between sessions. The suggestion that too much experience with one distortion cancels any transfer of advantage from this distortion to another is supported by the fact that the CB Group (overtrained on one distortion) failed to show any transfer to the new distortion on Day 5 while the SB Group showed a consistent daily decrease in initial error as a result of the previous experience. With only one day's exposure (a total of two minutes active adaptation with feedback) the SB Group showed significant positive transfer in an amount equal to the positive transfer of the CB Group which received the same base both days.

CONCLUSIONS

The results suggest that it may well be possible to train divers, out of the water, to perform more effectively immediately upon entering the water. Such training techniques might also be helpful in maintaining a state of competence in fairly experienced divers.

Further research to determine the most effective training procedure (including most effective distortion) and the most effective spacing of sessions should be conducted.

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13. ABSTRACT

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